

# Interdisciplinary Stuff

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**With a unique and broad scope of activity, yielding high quality research of international impact, agrophysics may be seen as a Polish specialty**

Agrophysics is a relatively new discipline that applies physical research methods and data analysis to various agricultural materials, products and processes that occur in ecosystems. Particular attention is given to sustainable plant and animal production, modern agricultural technologies, and the quality of raw materials and food products. Agrophysics covers all the physical and physicochemical interactions between soil, plant and atmosphere; the processes and parameters of harvesting, trans-

port, storage and processing of agricultural materials; as well as their modeling, prediction and control.

The import of agrophysical studies stems from the fact that around 30% of the earth's land is used for agricultural purposes, and 10% is under plough. These areas are usually very intensively used and subjected to monoculture cropping, where plant growth conditions are regulated by applying various agrotechnical management practices. Such intensive use frequently leads to soil erosion, structural deformation and chemical pollution. Humus loss is also a serious threat that causes harmful environmental effects, such as physical, chemical and biological degradation of soil, diminishing water resources and toxifying groundwaters. Changes in plant water supply, in turn, can limit food production and its quality.

The need to carry out and coordinate intensive research in these areas led the Polish Academy of Sciences to establish the Institute of Agrophysics in Lublin.

## Math-based agriculture

The unique character of the Institute's research has been consistently bolstered during over 30 years of specialization in our field. The high quality of this research is guaranteed by an interdisciplinary staff, comprising 23 physicists and mathematicians, 10 chemists, 22 engineers, 7 biologists and 11 agronomists, who collaborate intensively in their day to day work. To better understand problems of an agricultural nature, these experts have specialized in agricultural sciences, many of them achieving PhD degrees and professorships in agronomy/agrophysics.

The scientific activity of the Institute concentrates upon studying the physical properties and processes important for properly managing the soil environment and developing sustainable agriculture and food production. It also covers the elaboration and improvement of specific methods of physical measurements, computer modeling and monitoring.

Agrophysical modeling and computer simulation concerns such environmental and technological processes as: mass and energy exchange in the soil-plant-atmosphere system and agricultural products; regulation of the physical, physicochemical, hydrophysical, thermo-physical and biological properties of soil and plant structures; optimal fertilization systems; the physical characteristics of granular materials (soils, grains, flour); and the physical aspects of agricultural product processing. It is an intrinsic feature of such modeling that it idealizes the real system, taking only the parameters that play an



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Measurements taken using an automatic agro-climatic station, a thermal vision camera, and a Time Domain Reflectometry device for identifying the moisture and salinity of soil. Our Institute has been selling such devices in 20 countries for many years. Radio communications make it possible to create measurement networks as well as links to airborne and satellite observation systems

important role into account. The specific and complex goal of agrophysical modeling is to identify these parameters for a broad range of interacting objects, i.e. the atmosphere, soil, plant, machine, and product, and to deal with such individual parameters as: colloidal or polydispersive composition, capillary, cellular or tissue build up, temporal and spatial variability, inhomogeneity, and biological activity.

### Applied research

The results of agrophysical research find a broad range of applications in environment protection, soil science, crop production, soil tillage, agricultural engineering, and food technology. They are also applied in medical and military sciences, as well as in construction engineering. For example, equipment developed at the Institute of Agrophysics for measuring and monitoring moisture, water potential, salinity and temperature (TDR) has been used by many domestic and foreign research institutions. Our modification of rye combine-harvester elements for use in rape harvesting while minimizing grain yield loss has yielded significant economic benefit.

The various computer databases (covering the basic properties of arable soils from the main typological units) and maps (the physicochemical, redox and hydrophysical characteristics of Polish mineral soils) produced by our researchers find application in the proper management and use of soil and water, in correlating soil tillage methods with changes in soil properties, and in achieving optimal yields under diversified soil-climatic conditions. All such tools aid in estimating soil health and the conditions of safe food production. The collection of these data enriches the European soil database, which contains information on soil and water resources as well as fate of physical, physicochemical and biological processes in relation to weather conditions. This knowledge is vital for developing guidelines aimed at optimal agricultural land use.

To date, the Institute of Agrophysics has coordinated many research projects involving over 40 research groups. Agrophysics has thus become widely disseminated to many other Polish institutions: agricultural academies, universities and other institutes. Recently it has become the topic of regularly taught courses at Polish agricultural academies.

The Institute is entitled to supervise programs of study leading to Ph. D. and D. Sc degrees in the field of agronomy-agrophysics, and is also authorized to put forth candidates to receive professorships. Many outstanding scientists from various scientific institutions in Poland avail themselves of this possibility, choosing to achieve titles in the field via the Institute.

As a representative of the Polish agrophysics field, our Institute edits two scientific journals, *International Agrophysics* and *Acta Agrophysica*, and works actively in the European Research Area (various international projects,



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**The laboratory studies the physical properties of plant materials and soils. They are analyzed in a controlled atmosphere, under static and dynamic loads**

the 5th EU Framework Program). It has been honored with the status of an EU Centre of Excellence: "Applied Physics in Sustainable Agriculture - AGROPHYSICS."

Polish agrophysicists actively cooperate in international and domestic research, as is reflected in their active participation in many meetings and conferences. An ongoing cycle of international *Agrophysical Conferences*, which were initiated in 1976 by our Institute, are traditionally held every four years. The 8th such Conference will be held this year in Louven, Belgium.

The high caliber of agrophysics research in Poland has led to the establishment of the Committee of Agrophysics within the Polish Academy of Sciences' Division V (Agricultural and Veterinary Sciences), as well as to the broad activity of the Polish Agrophysical Society (PTA), which gathers together over 300 members and 7 regional divisions (in Lublin, Kraków, Poznań, Wrocław, Szczecin, Olsztyn and Rzeszów). The principal aim of the PTA is to promote agrophysical research, and has recently been directed towards forming divisions abroad. ■